PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : B08B 9/04, B63H 19/02 — A1

(11) International Publication Number: WO 86/ 01751

(43) International Publication Date: 27 March 1986 (27.03.86)

(21) International Application Number: PCT/NO85/00055

(22) International Filing Date: 17 September 1985 (17.09.85)

(31) Priority Application Number: 843686

(32) Priority Date: 17 September 1984 (17.09.84)

(33) Priority Country: NO

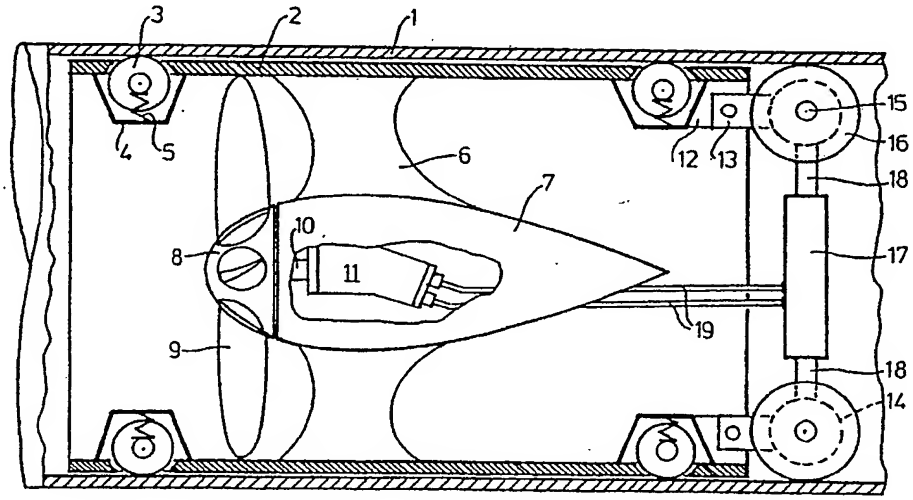
(71)(72) Applicant and Inventor: STORESUND, Per [NO/NO]; Åsane Senter 4, N-5095 Ulset (NO).

(74) Agent: A/S OSLO PATENTKONTOR DR.ING. K.O. BERG; Holtegaten 20, N-0306 Oslo 3 (NO).

(81) Designated States: AU, BE (European patent), BR, CF (OAPI patent), CG (OAPI patent), CM (OAPI patent), DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB (European patent), IT (European patent), JP, ML (OAPI patent), MR (OAPI patent), NL (European patent), NO, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.
With amended claims.

(54) Title: PIPELINE PIG



(57) Abstract

A pipeline pig comprises a body (2) provided with means (3) for positioning the pig in a pipeline (1). The body (2) will permit the fluid transported in the pipeline to flow through the pig without creating a substantial pressure drop. The pig is provided with a turbine (8) driven by the fluid flow therethrough, the turbine in turn driving wheels (16) biased against the pipeline wall. The power transmission may be accomplished by a pump (11) driven by the turbine (8), the pump output in turn driving hydraulic motors (14) connected to the wheels (16). An hydraulic cylinder (17) connected to the pump (11) may be used for biasing the wheels (16) against the pipeline. The drive system is preferably reversible, so that the pig may move both with and against the fluid flow in the pipeline. The pig may carry instrumentation for checking the condition of the pipeline, and power to this instrumentation may be provided by a generator driven by the turbine (8). Both the instrumentation and the reversing mechanism may be controlled by acoustical signals or an electronic computer included in the pig.

ISDOCID: <WO___8601751A1_I_>

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GA	Gabon	MR	Mauritania
AU	Australia	GB	United Kingdom	MW	Malawi
BB	Barbados	HU	Hungary	NL	Netherlands
BE	Belgium	IT	Italy	NO	Norway
BG	Bulgaria	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic			SE	Sweden
CG	Congo	KR	Republic of Korea	SN	Senegal
CH	Switzerland	LI	Liechtenstein	SU	Soviet Union
CM	Cameroon	LK	Sri Lanka	TD	Chad
DE	Germany, Federal Republic of	LU	Luxembourg	TG	Togo
DK	Denmark	MC	Monaco	US	United States of America
FI	Finland	MG	Madagascar		
FR	France	ML	Mali		

Pipeline pig.

Pipeline pigs are used for variety of purposes in the construction, operation and maintenance of pipelines for the transport of e.g. hydrocarbons. One very important function is testing submerged or buried pipelines for leaks, corrosion, erosion or other damage since pipelines of this type are not readily accessible from the outside. For these purposes the pigs may carry advanced equipment for performing and registering various measurements and a power source, normally in the form an electric battery.

Most conventional pigs of this type comprise an elongate body and one or more disks or cups at each end, the peripheral parts of the disk or cups being made of flexible material and fitting snuggly within the pipeline so that the pig will be carried along with the fluid flow in the pipeline. Thus, the pig cannot be controlled after it has been launched from one end of the pipeline, and at the other end a rather elaborate pig trap and sluice must be arranged for recovering the pig, preferably without damage to its advanced equipment. Some submerged pipelines extend for hundreds of kilometers between pumping stations and it is clearly inefficient to send a pig all that distance if, for instance, only the section of the pipeline closest to one or both of the end points needs checking. Furthermore, if the entire distance is to be controlled, it may be difficult to pack the pig with sufficient batteries to last all the way. In some underwater pipeline systems recovery of the pig is not possible in a conventional manner. In such systems, therefore, double parallel pipelines have been contemplated for returning the pig. This, of course, adds considerably to the cost and operational difficulties of the pipeline system.

Instead of scraper cups or the like that will make the pig move along with the flow in the pipeline, another type of conventional pig is moved by means of a cable attached to the pig. This cable normally also acts as an umbilical cord transmitting power and signals between the pig and the launching station. However, such pigs have rather short operational distance due to the limited length of the umbilical cord and, furthermore, handling of the umbilical cord is difficult.

A rather specialized type of pig, particularly intended for cleaning purposes, is known from US-PS No. 2 596 571. This pig comprises a main body fitting with a small clearance inside the pipeline so as to be carried along with the fluid flow. The casing has a number of axial passages which will permit some fluid flow through the pig, this flow being directed to impinge on the vanes of a turbine supported for free rotation in the main body. The turbine is provided with an excentric weight so that when the turbine rotates, the excentric weight causes an unbalanced rotating force which will set the entire pig vibrating in order to improve its cleaning capabilities and reduce the risk of it getting jammed by sediments in the pipeline. In other pigs of a similar type the turbine is made to drive a cutting or cleaning head mounted for rotation with respect to the body of the pig. Also this type suffers the disadvantages of not being controllable after launching and requiring special equipment and operating procedures for recovery.

Accordingly, it is an object of the present invention to provide an improved pipeline pig which will at least partly overcome some of the drawbacks and disadvantages of conventional pigs.

According to the invention, a pipeline pig is provided, comprising a body provided with means for positioning same in a pipeline and propulsion means

utilizing a pressure differential across the pig to propel the pig along the pipeline, said body having at least one generally axial passage to permit at least some flow therethrough of the fluid transported in the pipeline, said body further comprising rotatably supported means drivable by said flow for converting hydrostatic energy in said fluid into mechanical energy, the invention being characterized in that said rotatably supported means is coupled to at least one driving means being engagable with the inside of the pipeline for driving the pig along the pipeline.

With this arrangement the pig according to the invention will be able to move both against and with the fluid flow in the pipeline and stop wherever wanted. By making the drive mechanism reversible, it is possible to launch the pig from one point and make it return to the same point through the same pipeline after accomplishing its mission. The energy converting means may also be used to supply energy to instrumentation carried by the pig. Since all energy required may be taken out of the pipeline flow, there is no limit to the distance the pig may travel.

Further advantageous features of the invention are defined in the dependent claims and are explained in greater detail in conjunction with the following description of the exemplifying embodiment shown in the appended drawing.

The drawing shows a side elevation, partly in section, of a pig according to the invention situated inside a pipeline, with some parts broken away.

The pipeline is designated 1. The pig comprises a body 2 consisting generally of a piece of pipe having an external diameter somewhat smaller than the internal diameter of the pipeline 1. The body 2 is provided with wheels 3 supported for rotation and limited radial movement in wheel wells 4 and biased towards the inside of the pipeline 1 by

means of a spring 5. Thus, the wheels 3 will keep the body 2 of the pig centered in the pipeline.

Inside the body 2 radial webs 6 support a housing 7 shaped generally like a drop in order to represent the least possible flow resistance. The nose of the housing is a turbine 8 with vanes 9. The turbine is mounted on the input shaft 10 of a hydraulic pump 11.

In conjunction with the rear wheel wells 4 brackets 12 are arranged forming supports for pivotable arms 13. Each arm 13 carries an hydraulic motor 14 (shown in broken lines), on the output shaft 15 of which a drive wheel 16 is mounted. The drive wheels 16 are forced against the pipeline wall by means of a hydraulic cylinder 17 with piston rods 18. The cylinder 17 is hydraulically connected to the pump 11 by means of lines 19. The motors 14 are also connected (not shown) to these lines, e.g. through internal passages in the cylinder 17 and piston rods 18.

In operation, the pipeline fluid will be flowing through the body 2 of the pig, e.g. from the left to the right in the drawing. This flow will be impinging on the vanes 9 so as to drive the turbine 8 in rotation, thus also rotating the input shaft 10 of the pump 11. Hydraulic fluid under pressure will flow from the pump to the cylinder 17, so that the piston rods 18 will force the wheels 15 against the pipeline wall. Hydraulic fluid from the pump will also flow to the motors 14 for rotating the wheels 16. The direction of rotation of the wheels 16 may be such that the pig will move from the right to the left in the drawing, i.e. against the direction of flow in the pipeline. The hydraulic motors 14 being reversible, the direction of rotation of the wheels may be changed by simply switching the flow direction through the motors, thus making the pig move in the opposite direction, i.e. the same as the pipeline

flow.

It will be understood that the pump 11 and the hydraulic motors 14 may be replaced by electrical equivalents, i.e. an electric generator and electric motors. Furthermore, hydraulic and electric systems may be combined, particularly where electric power is needed for instrumentation (not shown) to be carried by the pig. It will also be obvious to the skilled person that the driving system may be purely mechanical, the rotation of the shaft 10 being transmitted to the wheels 16 through suitable shafts and gearing.

Varying the speed and driving force of the pig may be accomplished in various ways, depending on the drive system. If mechanical, the gear ratio may simply be changed. If hydraulic, the pump may be of the variable capacity type being able to deliver higher pressure at lower flow rates. Also, the pitch angle of the turbine vanes 9 may be changed.

Means will normally be included in the pig for controlling its movements and instrumentation. Such control means may in turn be controlled by acoustical signals, as is well known in the art, or by means of a programmable micro computer, which is also well known in the art. The pig may also include equipment for automatically reversing the direction of travel when the pig arrives at the end of the pipeline or encounters an obstacle which cannot be passed.

It will be understood that the embodiment shown in the drawing is schematic only and that the various component parts may be varied or modified by the skilled person without departing from the spirit of the invention and the scope of the appended claims. Thus, the body of the pig need not be constituted by an elongate cylinder with a diameter close to that of the pipeline, but may take various other forms adapted to the purpose of the pig, e.g. so as to make it able to negociate bends in the pipeline. The

drive wheels may be replaced by caterpillars, and the rotating motors may be replaced by linear motors moving the pig in a stepwise fashion. The pig may comprise more than one turbine, e.g. one for propelling the pig and another for producing power for the instrumentation and control circuitry. For redundancy, two or more turbines may be used for each of these functions. Furthermore. it will be understood that the invention may be employed with either gaseous or liquid fluids in the pipeline. If the pipeline and fluid are clean, the fluid may even be used as the working medium in a fluidbased energy transmission system.

C l a i m s:

1. A pipeline pig, comprising a body provided with means for positioning same in a pipeline and propulsion means utilizing a pressure differential across the pig to propel the pig along the pipeline, said body having at least one generally axial passage to permit at least some flow therethrough of the fluid transported in the pipeline, said body furthermore comprising rotatably supported means drivable by said flow for converting hydrostatic energy in said fluid into mechanical energy, c h a r a c t e r i z e d in that said rotatbly supported means (8) is coupled to at least one driving means (16) being engagable with the inside of the pipeline (1) for driving the pig along the pipeline.

2. A pipeline pig according to claim 1, c h a r a c t e r i z e d in that said rotatably supported, drivable means (8) is coupled mechanically to said at least one driving means (16).

3. A pipeline pig according to claim 1, c h a r a c t e r i z e d in that said rotatably supported, drivable means (8) is coupled to said at least one driving means (16) through a hydraulic pump (11) and a hydraulic motor (14).

4. A pipeline pig according to claim 1, c h a r a c t e r i z e d in that an electric generator and an electric motor are included between said rotatably supported, drivable means (8) and said at least one driving means (16).

5. A pipeline pig according to any of the preceding claims, c h a r a c t e r i z e d in that said at least one driving means comprises a wheel (16) supported for limited movement with respect to

said body (2), means (17, 18) being provided for biasing the wheel (16) against the inner wall of the pipeline (1).

6. A pipeline pig according to any of the claims 1 - 4, c h a r a c t e r i z e d in that it comprises instrumentation for controlling parameters of the pipeline (1), and a source of power for the instrumentation driven by said rotatably supported means (8).

7. A pipeline pig according to any of the claims 1 - 4, c h a r a c t e r i z e d in that it comprises means for reversing the travelling direction of the pig.

8. A pipeline pig according to claim 7, c h a r a c t e r i z e d in that it comprises means for acoustically controlling said reversing means.

9. A pipeline pig according to claim 7, c h a r a c t e r i z e d in that it comprises a programmable computer for controlling said reversing means.

10. A pipeline pig according to claim 7, c h a r a c t e r i z e d in that it comprises means arranged to activate said reversing means if the pig encounters an insurmountable obstruction in the pipeline.

AMENDED CLAIMS

[received by the International Bureau on 27 January 1986 (27.01.86); original claims 1-10 replaced by amended claims 1-8 (2 pages)]

1. A pipeline pig, comprising a body provided with means for positioning same in a pipeline and propulsion means utilizing a pressure differential across the pig to propel the pig along the pipeline, said body having at least one generally axial passage to permit at least some flow therethrough of the fluid transported in the pipeline, said body furthermore comprising rotatably supported means drivable by said flow for converting hydrostatic energy in said fluid into mechanical energy, said rotatably supported means (8) being coupled to at least one driving means (16) being engagable with the inside of the pipeline (1) for driving the pig along the pipeline in the fluid flow direction, c h a r a c t e r i z e d in that it comprises means for reversing the travelling direction of the pig.

2. A pipeline pig according to claim 1, c h a r a c t e r i z e d in it comprises means for acoustically controlling said reversing means.

3. A pipeline pig according to claim 1 or 2, c h a r a c t e r i z e d in that it comprises a programmable computer for controlling said reversing means.

4. A pipeline pig according to claim 1 or 2, c h a r a c t e r i z e d in that it comprises means arranged to activate said reversing means if the pig encounters an insurmountable obstruction in the pipeline.

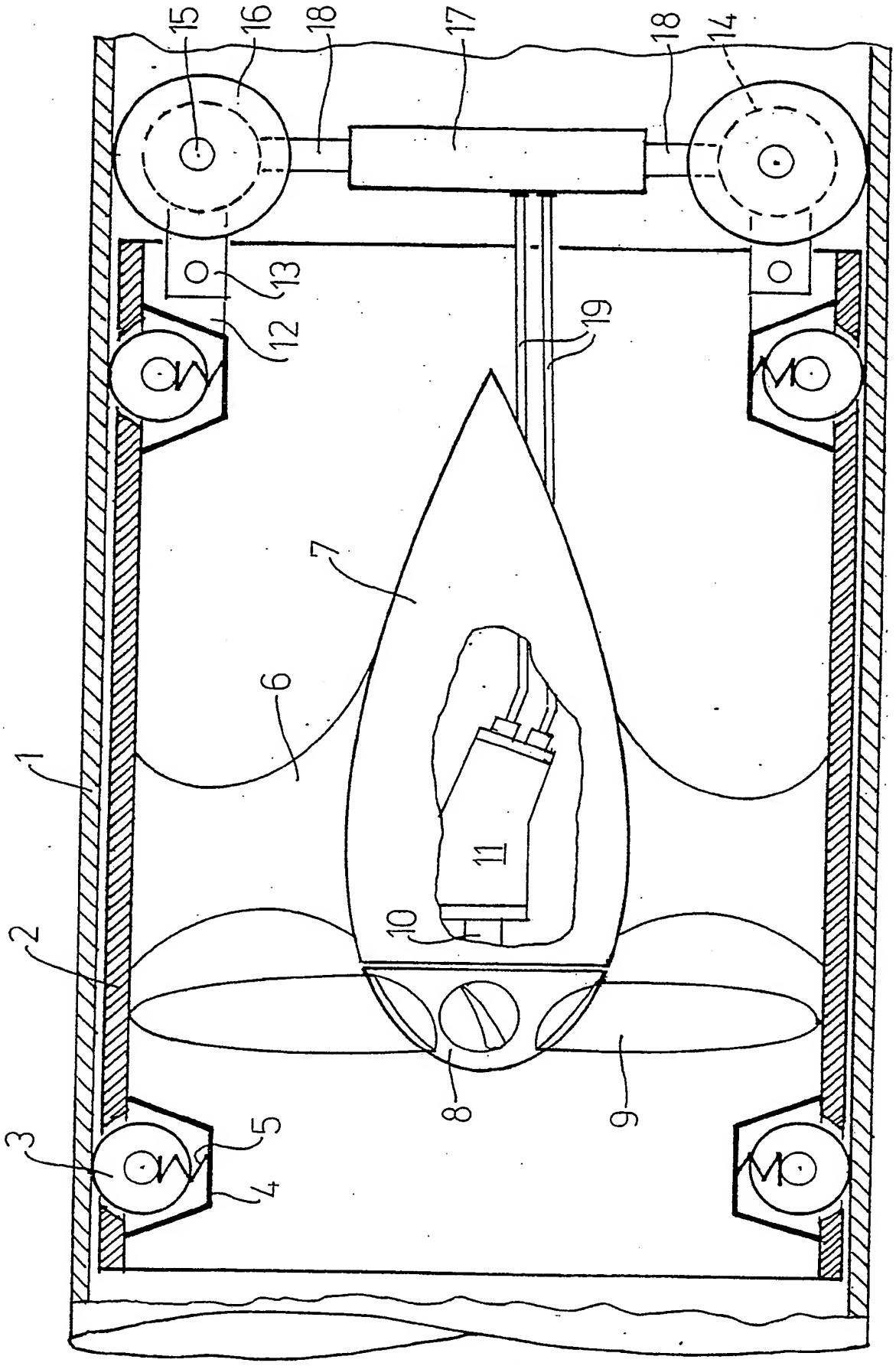
5. A pipeline pig according to claim 1 or 2, c h a r a c t e r i z e d in that said rotatably supported, drivable means (8) is coupled to said at

least one driving means (16) through a hydraulic pump (11) and a hydraulic motor (14).

6. A pipeline pig according to claim 1, characterized in that an electric generator and an electric motor are included between said rotatably supported, drivable means (8) and said at least one driving means (16).

7. A pipeline pig according to claim 1 or 2, characterized in that said at least one driving means comprises a wheel (16) supported for limited movement with respect to said body (2), means (17, 18) being provided for biasing the wheel (16) against the inner wall of the pipeline (1).

8. A pipeline pig according to claim 1 or 2, characterized in that it comprises instrumentation for controlling parameters of the pipeline (1), and a source of power for the instrumentation driven by said rotatably supported means (8).



INTERNATIONAL SEARCH REPORT

PCT/NO85/00055

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

B 08 B 9/04, B 63 H 19/02

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	B 08 B 9/00-/06; E 03 F 9/00; E 03 C 1/30-/308; B 63 H 19/00-/08
US Cl	15:104.02-104.18, 104.3; 138:8, 22-24, 166-171

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	DE, C, 225 176 (J. BEISEL ET AL) 18 August 1910	1, 2
X	US, A, 3 056 155 (L.D. HARMES) 2 October 1962 (Col. 2, lines 23-48)	1, 2, 3, 5, 6
Y	US, A, 645 894 (C.S. DEAN) 20 March 1900	1, 2, 5
A	US, A, 1 695 831 (L.R. TITCOMB ET AL) 18 December 1928	1
A	US, A, 2 248 742 (C.H.M. BURNHAM) 8 July 1941	1
A	US, A, 2 698 449 (R.A. RAFFERTY) 4 January 1955	1, 5, 7
A	US, A, 3 058 137 (E.N. DOYLE ET AL) 16 October 1962	1, 3, 5

.../...

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1985-11-18	1985 -11- 28
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Hans Furhem

L.E

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 3 525 111 (P.VON ARX) 25 August 1970	1
A	DE, C, 806 947 (B.STARK) 21 June 1951 (Vessel propulsion against flow)	7
A	DE, B, 1 076 583 (J. MÜLLER) 25 February 1960	7, 10
A	Derwent's abstract No. K 6169 C/44, SU-722 615 (5 April 1980)	4